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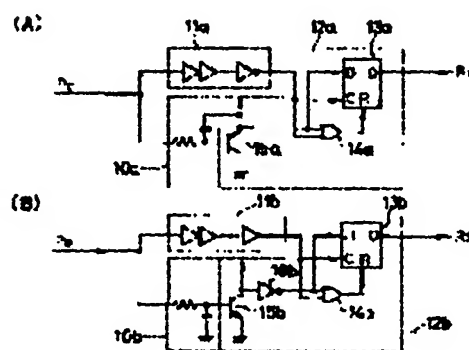
(72)Inventor : JOKURA ATSUSHI

(54) PLL CIRCUIT

(57)Abstract:

PURPOSE: To improve S/N of the PLL circuit in the frequency synthesizer of a reception system by providing a dead zone for phase comparison and realizing stable synchronous convergence.

CONSTITUTION: A phase leading PD pulse is delayed by a delay device 11b and is inputted to the clock input of a D-FF 13b. The PD pulse is integrated by a time constant circuit 10b, and this integral waveform is compared with the threshold of a transistor TR 15b, and a pulse is generated when it is larger than this threshold. This pulse is inputted to the data input of the D-FF 13b to latch the PD pulse, and the D-FF 13b is reset by an OR gate 14b at the time of disappearance of the PD pulse. Its Q output RD is supplied to a charge pump and a loop filter to obtain the control voltage of a VCO. Consequently, the dead zone is determined by CR of the time constant circuit 10b and the threshold of the TR 15b, and the PD pulse larger than the dead zone is outputted as it is, and therefore, synchronous convergence is stabilized.



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CLAIMS

[Claim(s)]

[Claim 1] An armature-voltage control oscillation means and a phase-comparison means to make the phase comparison of this oscillation output frequency signal and external oscillation signalling frequency, It is a PLL circuit including a control-voltage generation means to generate the control voltage of the aforementioned armature-voltage control oscillation means according to this phase-comparison output. the aforementioned control-voltage generation means A delay means by which the aforementioned phase-comparison output is delayed, and the time constant circuit which considers the aforementioned phase-comparison output as an input, The PLL circuit characterized by being constituted including a latch means to cancel this latch state when the output state of the aforementioned time constant circuit is latched and the output of the aforementioned delay means disappears by the output of the aforementioned delay means so that the aforementioned control voltage may be generated using this latch output.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the PLL circuit used in order to obtain the stable synchronizing signal in strange recovery technology about a PLL (phase locked loop) circuit.

[0002]

[Description of the Prior Art] A PLL circuit detects the phase contrast of the reference frequency signal given from the outside, and the dividing output which carried out dividing of the oscillation output of VCO (voltage controlled oscillator), controls VCO by direct current voltage according to the phase contrast, and obtains a stable oscillation output.

[0003] In the receiving system, it mixed with the receiving RF signal by having made this oscillation output into the local oscillation signal, and the IF signal was created and alignment has been obtained for the frequency change at the time of a channel change by changing the division ratio of a counting-down circuit (program divider), or using a direct digital synthesizer etc. and changing the reference frequency signal itself to the source of a signal.

[0004] In local oscillation frequency synthesizer SASHIZA, for a high-speed frequency change, the high interest profit design of a system is performed, but on the other hand noise bandwidth becomes large, it is easy to incorporate noise in a system, and C/N-ary of an oscillation output pose a problem. The method of extending the neutral zone (DETTO zone) in a phase comparison as a negative measure in such a case is taken.

[0005] Drawing 5 is the circuit diagram showing the portion of the phase comparator of the conventional PLL circuit shown in JP,63-260317,A. reference frequency signal fR with which the 1st D-FF and 23 were impressed to the 2nd D-FF, and 24 was impressed [21] to the clocked-into terminal of 1st D-FF22 for a charge pump and 22 The 1st delayed delay circuit and dividing signal fP with which 25 was impressed to the clocked-into terminal of 2nd D-FF23 It is the 2nd delayed delay circuit. 25 and 24 are delay circuits and 28 and 29 are the DETTO zone expansion signal DZ. It is the circuit which responds and chooses the amount of delay.

[0006] Next, operation is explained. input terminal D1 of D-FF22 **** -- reversal output Q2 of D-FF it impresses -- having -- input terminal D2 of D-FF23 **** -- reversal output Q1 of D-FF22 it impresses -- having -- output Q1 it is impressed by the gate of NMOS26 of the charge pump circuit 21 -- having -- output Q2 It is impressed by the gate of NMOS27.

[0007] DETTO zone expansion signal DZ If it turns OFF ("0"), the delay signal of the last stage of a delay circuit will be chosen from selection circuitries 28 and 29.

[0008] First, dividing signal fP It receives and is the reference frequency signal fR. It is fP, as it is shown in drawing 6 (A), when the phase is in agreement. fR By the standup, both D-FF 22 and 23 incorporate a mutual reversal output "1", and it is an output Q1 respectively. And Q2 It outputs. These outputs Q1 and Q2 It goes up by the inclination shown as a solid line like drawing 6 (C), and is threshold voltage Vt. It is TD the time of reaching. Output R1 of selection circuitries 28 and 29 R2 It starts.

[0009] That is, the amount of the maximum delay of delay circuits 24 and 25 is TD. It has designed so that it may become equal, and it is an output R1 and R2. It is reset and both D-FF 22 and 23 are outputs Q1 and Q2. It falls, therefore neither of NMOSes 26 and 27 turn on in this case, and the output PD according to phase contrast is not outputted.

[0010] As shown by drawing 6 (B), after fR ' has become early for 10ns, D-FF22 incorporates "1" and is an output Q1. It starts like dotted-line ** of (C). It is behind for 10ns and D-FF23 is fP. "1" is incorporated in a standup and it is the output Q2. It goes up. Next, when R1 ' is outputted from a selection circuitry 28, it is reset and D-FF23 is an output Q2. Vt Before reaching, it falls like dashed line ** of (C).

[0011] On the other hand, it is the output Q1 of D-FF22. Vt It reaches and is the output R2 of a selection circuitry 29. D-FF22 will be reset. Therefore, output Q1 Vt The period which became above, and NMOS26 are turned on, and the output PD according to phase contrast "0" is outputted. That is, in the case of drawing 6 (C), it is fR. When it becomes early, it is an output R2. Before being outputted, it is surely Vt. Reaching, a dead zone serves as zero.

[0012] Next, DZ= "1" is a case and, as for drawing 6 (D), the delay signal with few amounts of delay than the time of DZ=

"0" is chosen. It is fR first. fP When the phase is in agreement, it is the output R1 of a delay circuit. R2 What is generated is TD. Since it becomes early, it is Q1. Q2 Vt D-FF 22 and 23 is reset without reaching.

[0013] Now and output R1 R2 TD It is fR when it is a delay signal early for 10ns. When it becomes early for 10ns like drawing 6 (D), it is the output Q1 of D-FF22. It goes up, as shown by the solid line of (D), and it is Vt. Since an output R2 occurs just before reaching, D-FF22 is reset, and it is Q1. It falls.

[0014] Therefore, in the case of drawing 6 (E), it is fR. fP Phase contrast is an output Q1 within in 10ns. Vt Output PD corresponding to [before reaching D-FF22 will surely be reset and NMOS26 is turned on, and] phase contrast It is not generated. That is, the dead zone for 10ns is prepared. the same -- fP if it comes out 10 or less ns when it becomes earlier than fR -- output Q2 of D-FF23 Vt Since D-FF23 is reset before reaching, the dead zone for 10ns occurs.

[0015] By preparing a dead zone, frequent generating of a control pulse which serves as disturbance of VCO in the state where the PLL circuit locks was prevented, and noise signals, such as a jitter nozzle, were also omitted, and S/N is improved sharply.

[0016]

[Problem(s) to be Solved by the Invention] In the PLL circuit constituted from a conventional phase-comparison circuit mentioned above, there is a problem on which the reaction of a system becomes slow to the phase contrast near the dead zone.

[0017] For example, fR fP When the case where received and it becomes early for 12ns is assumed, it comes to be shown in drawing 7. In the state of the dead zone 0 of $DZ = "0"$, it is an output Q1. Vt It can put at about 12ns and the time it is over is PD. Although "1" is outputted for 12ns as a signal a dead-zone 10ns [of $DZ = "1"$] state -- output Q1 Vt about 2ns of time to exceed -- becoming -- PD As a signal, for 2ns continues but the rate of the integration voltage value change which controls VCO which lets a loop filter pass boils "1" dully.

[0018] If the property of this phase comparison is shown in drawing, it will become like drawing 8. fR fP Since the time which sees relatively and is deleted in 10ns for the dead-zone setup becomes small when phase contrast is large, although influence decreases, the sensitivity as a remarkable system deteriorates near the dead zone.

[0019] Specifically, although it is convenient to change to near shift frequency at the time of the change of the oscillation frequency of a PLL circuit, alignment near a convergence value is affected and there is a trouble which the phenomenon in which vibration drags on to a convergence value tends to produce.

[0020] The purpose of this invention is offering the PLL circuit which enabled stable synchronous convergence, preparing a dead zone at the time of a phase comparison.

[0021]

[Means for Solving the Problem] A phase-comparison means to make the phase comparison of an armature-voltage control oscillation means, and this oscillation output frequency signal and external oscillation signalling frequency according to this invention, It is a PLL circuit including a control-voltage generation means to generate the control voltage of the aforementioned armature-voltage control oscillation means according to this phase-comparison output. the aforementioned control-voltage generation means A delay means by which the aforementioned phase-comparison output is delayed, and the time constant circuit which considers the aforementioned phase-comparison output as an input, When the output state of the aforementioned time constant circuit is latched and the output of the aforementioned delay means disappears by the output of the aforementioned delay means, the PLL circuit characterized by being constituted including a latch means to cancel this latch state so that the aforementioned control voltage may be generated using this latch output is obtained.

[0022]

[Example] It explains in detail, referring to a drawing about the example of this invention below.

[0023] Drawing 1 is the block diagram of the example of this invention, and is reference frequency fR. The output of generated VCO 1 turns into one input of a phase comparator 3. Frequency fP which carried out dividing of the oscillation frequency of VCO7 to the other inputs of this phase comparator 3 with the counting-down circuit 2 The signal is impressed.

[0024] It is the lead signal PD of the pulse width according to the phase contrast from a phase comparator 3. It is behind, Signal PU is outputted and it is inputted into filter circuits 4a and 4b, respectively. These filter circuits 4a and 4b are circuits of the feature portion of this invention, and the one example is shown in drawing 2. They are PD and PU, a dead zone being set up in these filter circuits 4a and 4b. Phase contrast signals RU and RD with which pulse width (phase contrast information is included) does not change It is generated.

[0025] These phase contrast signals RU and RD It becomes the control voltage of VCO7 by being inputted into a loop filter 6 and finding the integral through the charge pump 5.

[0026] The output of this VCO7 serves as local oscillation frequency in a receiving system, change instructions of a receiving channel are answered, the oscillation frequency fR of reference frequency VCO 1 and the division ratio of the program divider 2 are controlled, and the PLL frequency synthesizer is constituted.

[0027] Drawing 2 (A) and (B) are each example circuit diagram of the filter circuits 4a and 4b of drawing 1. First, if

drawing 2 (A) is referred to, it is the lead signal PU. It is inputted into delay circuit 11a and time constant circuit 10a, respectively. The delay output of delay circuit 11a turns into a clocked input of D-FF13a which constitutes latch circuit 12a. [0028] The output of time constant circuit 10a turns into a base input of PNP transistor 15a which constitutes latch circuit 12a, and the emitter output of this transistor 15a turns into one input of OR-gate 14a while turning into a data input of D-FF13a. The delay output of delay circuit 11a is impressed to the other inputs of this OR-gate 14a, or the output is the reset input of D-FF13a. And the reversal Q output of D-FF13a is RU. It becomes.

[0029] Drawing 2 (B) is the delay signal PD. Although it consists of delay circuit 11b, time constant circuit 10b, and latch circuit 12b concretely also about the side The polarity of the power supply line of time constant circuit 10b and the polarity of transistor 15b in a latch circuit progress, and it is Signal PU. It has become contrary to a side. Moreover, the collector output of transistor 15b is inverted in inverter 16b, and is the data input of D-FF13b, and one input of OR-gate 14b.

[0030] Drawing 3 is each signal wave form view showing operation of the circuit of drawing 2 (B), and is fR. fP When it receives and a phase is overdue, it is the delay signal PD. Two PDs from which it is a thing at the time of being outputted, and it is behind in this example, and a degree differs The pulse is shown.

[0031] PD shown in (C) A pulse is changed into the loose wave (integration wave) of the standup shown in (d) with the time constant of time constant circuit 10b. This wave is the threshold V_t of transistor 15b. PD which is not attained By the pulse, transistor 15b does not turn on and, therefore, the data input signal (D input signal) from inverter 16b to D-FF13b is not generated. On the other hand, an integration wave is Threshold V_t . PD to attain By the pulse, transistor 15b is generated, as it turns on and a data input signal shows (e) from inverter 16b, and for this data input signal, an integration wave is Threshold V_t . It is generated until it becomes smallness.

[0032] the clocked input of D-FF13b -- PD a pulse -- time t_D only -- **** delay PD shown in delayed (f) The pulse is supplied. Here, it is a time delay t_D . Same [in the time t_M (refer to drawing (e)) to become settled with the time constant of time constant circuit 10b / almost] or it is t_M . t_D If it selects to smallness a little, it synchronizes with the standup timing of a clock signal (delay pulse PD), and a data input signal is incorporated and latched to D-FF13b.

[0033] Delay PD It is the filter circuit output RD which a latch state is reset and is shown in (g) as a result since D-FF13b will be reset by the output of OR-gate 14b, if a pulse falls. It will be obtained.

[0034] Therefore, lead signal PD according to phase contrast Therefore, it is the threshold V_t of filter circuit 12b, without being inputted into the latter charge pump 5 by letting filter circuit 4b (drawing 1) pass depending on the degree of the phase contrast. Time t_M to become settled It becomes a dead zone.

[0035] phase-lead-lag-network signal PD exceeding a dead zone ***** -- without the wave of the pulse changing, since there is no bird clapper dully like the former comparatively, the thing of the integration [by which it is outputted to the charge pump 5] voltage value change which controls [near the dead zone / come out and] VCO7 shown in drawing 4 as a phase-comparison property is obtained

[0036] In addition, outputs RU and RD of filter circuits 4a and 4b PU and PD Receiving time delay TD If it attaches, it is a dead zone t_M . It can compare and ignore at the convergence time (order for 1 or less ms) demanded also as 100ns (10MHZ) or more than it at the time of the channel change of local oscillation frequency.

[0037] Stopping at the circuit of drawing 2 only being shown in an example, it is clear for various circuit deformation to be possible.

[0038]

[Effect of the Invention] There is an effect that a highly efficient PLL circuit without vibration near the convergence value or a tailing phenomenon is realizable, at the time of a channel change, setting up the dead zone in a phase comparison, when PLL is designed by high interest profit for the high-speed channel change which was described above and which is demanded in a PLL receiving system like according to this invention.

[0039] If it states quantitatively, there is an improvement of 10dB or more with an S/N value, and shortening for 2ms or more can be aimed at in channel change convergence time.

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TECHNICAL FIELD

[Industrial Application] Especially this invention relates to the PLL circuit used in order to obtain the stable synchronizing signal in strange recovery technology about a PLL (phase locked loop) circuit.

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PRIOR ART

[Description of the Prior Art] A PLL circuit detects the phase contrast of the reference frequency signal given from the outside, and the dividing output which carried out dividing of the oscillation output of VCO (voltage controlled oscillator), controls VCO by direct current voltage according to the phase contrast, and obtains a stable oscillation output.

[0003] In the receiving system, it mixed with the receiving RF signal by having made this oscillation output into the local oscillation signal, and the IF signal was created and alignment has been obtained for the frequency change at the time of a channel change by changing the division ratio of a counting-down circuit (program divider), or using a direct digital synthesizer etc. and changing the reference frequency signal itself to the source of a signal.

[0004] In local oscillation frequency synthesizer SASHIZA, for a high-speed frequency change, the high interest profit design of a system is performed, but on the other hand noise bandwidth becomes large, it is easy to incorporate noise in a system, and C/N-ary of an oscillation output pose a problem. The method of extending the neutral zone (DETTO zone) in a phase comparison as a negative measure in such a case is taken.

[0005] For a charge pump and 22, 21 is the reference frequency signal fR with which drawing 5 was the circuit diagram showing the portion of the phase comparator of the conventional PLL circuit shown in JP,63-260317,A, the 1st D-FF and 23 were impressed to the 2nd D-FF, and 24 was impressed to the clocked-into terminal of 1st D-FF22. 25 is the 1st delayed delay circuit and the dividing signal fP impressed to the clocked-into terminal of 2nd D-FF23. It is the 2nd delayed delay circuit. 25 and 24 are delay circuits and 28 and 29 are the DETTO zone expansion signal DZ. It is the circuit which responds and chooses the amount of delay.

[0006] Next, operation is explained. input terminal D1 of D-FF22 **** -- reversal output Q2 of D-FF it impresses -- having -- input terminal D2 of D-FF23 **** -- reversal output Q1 of D-FF22 it impresses -- having -- output Q1 it is impressed by the gate of NMOS26 of the charge pump circuit 21 -- having -- output Q2 It is impressed by the gate of NMOS27.

[0007] DETTO zone expansion signal DZ If it turns OFF ("0"), the delay signal of the last stage of a delay circuit will be chosen from selection circuitries 28 and 29.

[0008] First, dividing signal fP It receives and is the reference frequency signal fR. It is fP, as it is shown in drawing 6 (A), when the phase is in agreement. fR By the standup, both D-FF 22 and 23 incorporate a mutual reversal output "1", and it is an output Q1 respectively. And Q2 It outputs. These outputs Q1 and Q2 It goes up by the inclination shown as a solid line like drawing 6 (C), and is threshold voltage Vt. It is TD the time of reaching. Output R1 of selection circuitries 28 and 29 R2 It starts.

[0009] That is, the amount of the maximum delay of delay circuits 24 and 25 is TD. It has designed so that it may become equal, and it is an output R1 and R2. It is reset and both D-FF 22 and 23 are outputs Q1 and Q2. It falls, therefore neither of NMOSes 26 and 27 turn on in this case, and the output PD according to phase contrast is not outputted.

[0010] As shown by drawing 6 (B), after fR ' has become early for 10ns, D-FF22 incorporates "1" and is an output Q1. It starts like dotted-line ** of (C). It is behind for 10ns and D-FF23 is fP. "1" is incorporated in a standup and it is the output Q2. It goes up. Next, when R1 ' is outputted from a selection circuitry 28, it is reset and D-FF23 is an output Q2. Vt Before reaching, it falls like dashed line ** of (C).

[0011] On the other hand, it is the output Q1 of D-FF22. Vt It reaches and is the output R2 of a selection circuitry 29. D-FF22 will be reset. Therefore, output Q1 Vt The period which became above, and NMOS26 are turned on, and the output PD according to phase contrast "0" is outputted. That is, in the case of drawing 6 (C), it is fR. When it becomes early, it is an output R2. Before being outputted, it is surely Vt. Reaching, a dead zone serves as zero.

[0012] Next, DZ= "1" is a case and, as for drawing 6 (D), the delay signal with few amounts of delay than the time of DZ= "0" is chosen. It is fR first. fP When the phase is in agreement, it is the output R1 of a delay circuit. R2 What is generated is TD. Since it becomes early, it is Q1. Q2 Vt D-FF 22 and 23 is reset without reaching.

[0013] Now and output R1 R2 TD It is fR when it is a delay signal early for 10ns. When it becomes early for 10ns like drawing 6 (D), it is the output Q1 of D-FF22. It goes up, as shown by the solid line of (D), and it is Vt. Since an output R2 occurs just before reaching, D-FF22 is reset, and it is Q1. It falls.

[0014] Therefore, in the case of drawing 6 (E), it is fR. fP Phase contrast is an output Q1 within in 10ns. Vt Output PD corresponding to [before reaching D-FF22 will surely be reset and NMOS26 is turned on, and] phase contrast It is not generated. That is, the dead zone for 10ns is prepared. the same -- fP if it comes out 10 or less ns when it becomes earlier than fR -- output Q2 of D-FF23 Vt Since D-FF23 is reset before reaching, the dead zone for 10ns occurs.

[0015] By preparing a dead zone, frequent generating of a control pulse which serves as disturbance of VCO in the state where the PLL circuit locks was prevented, and noise signals, such as a jitter nozzle, were also omitted, and S/N is improved sharply.

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EFFECT OF THE INVENTION

[Effect of the Invention] There is an effect that a highly efficient PLL circuit without vibration near the convergence value or a tailing phenomenon is realizable, at the time of a channel change, setting up the dead zone in a phase comparison, when PLL is designed by high interest profit for the high-speed channel change which was described above and which is demanded in a PLL receiving system like according to this invention.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the PLL circuit constituted from a conventional phase-comparison circuit mentioned above, there is a problem on which the reaction of a system becomes slow to the phase contrast near the dead zone.

[0017] For example, fR fP When the case where received and it becomes early for 12ns is assumed, it comes to be shown in drawing 7. In the state of the dead zone 0 of DZ = "0", it is an output Q1. Vt It can put at about 12ns and the time it is over is PD. Although "1" is outputted for 12ns as a signal a dead-zone 10ns [of DZ = "1"] state -- output Q1 Vt about 2ns of time to exceed -- becoming -- PD As a signal, for 2ns continues but the rate of the integration voltage value change which controls VCO which lets a loop filter pass boils "1" dully.

[0018] If the property of this phase comparison is shown in drawing, it will become like drawing 8. fR fP Since the time which sees relatively and is deleted in 10ns for the dead-zone setup becomes small when phase contrast is large, although influence decreases, the sensitivity as a remarkable system deteriorates near the dead zone.

[0019] Specifically, although it is convenient to change to near shift frequency at the time of the change of the oscillation frequency of a PLL circuit, alignment near a convergence value is affected and there is a trouble which the phenomenon in which vibration drags on to a convergence value tends to produce.

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MEANS

[Means for Solving the Problem] They are the time constant circuit which is the PLL circuit which includes an armature-voltage-control oscillation means, a phase-comparison means make the phase comparison of this oscillation output-frequency signal and external oscillation signalling frequency, and a control-voltage generation means generate the control voltage of the aforementioned armature-voltage-control oscillation means according to this phase-comparison output according to this invention, and the aforementioned control-voltage generation means carries out as an input in a delay means to by_ which the aforementioned phase-comparison output is delayed, and the aforementioned phase-comparison output, and the output of the aforementioned delay means. When the output state of the aforementioned time constant circuit is latched and the output of the aforementioned delay means disappears, the PLL circuit characterized by being constituted including a latch means to cancel this latch state so that the aforementioned control voltage may be generated using this latch output is obtained.

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EXAMPLE

[Example] It explains in detail, referring to a drawing about the example of this invention below.

[0023] Drawing 1 is the block diagram of the example of this invention, and is reference frequency f_R . The output of generated VCO 1 turns into one input of a phase comparator 3. Frequency f_P which carried out dividing of the oscillation frequency of VCO7 to the other inputs of this phase comparator 3 with the counting-down circuit 2 The signal is impressed.

[0024] It is the lead signal PD of the pulse width according to the phase contrast from a phase comparator 3. It is behind, Signal PU is outputted and it is inputted into filter circuits 4a and 4b, respectively. These filter circuits 4a and 4b are circuits of the feature portion of this invention, and the one example is shown in drawing 2. They are PD and PU, a dead zone being set up in these filter circuits 4a and 4b. Phase contrast signals RU and RD with which pulse width (phase contrast information is included) does not change It is generated.

[0025] These phase contrast signals RU and RD It becomes the control voltage of VCO7 by being inputted into a loop filter 6 and finding the integral through the charge pump 5.

[0026] The output of this VCO7 serves as local oscillation frequency in a receiving system, change instructions of a receiving channel are answered, the oscillation frequency f_R of reference frequency VCO 1 and the division ratio of the program divider 2 are controlled, and the PLL frequency synthesizer is constituted.

[0027] Drawing 2 (A) and (B) are each example circuit diagram of the filter circuits 4a and 4b of drawing 1. First, if drawing 2 (A) is referred to, it is the lead signal PU. It is inputted into delay circuit 11a and time constant circuit 10a, respectively. The delay output of delay circuit 11a turns into a clocked into of D-FF13a which constitutes latch circuit 12a.

[0028] The output of time constant circuit 10a turns into a base input of PNP transistor 15a which constitutes latch circuit 12a, and the emitter output of this transistor 15a turns into one input of OR-gate 14a while turning into a data input of D-FF13a. The delay output of delay circuit 11a is impressed to the other inputs of this OR-gate 14a, or the output is the reset input of D-FF13a. And the reversal Q output of D-FF13a is RU. It becomes.

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[0030] Drawing 3 is each signal wave form view showing operation of the circuit of drawing 2 (B), and is f_R . f_P When it receives and a phase is overdue, it is the delay signal PD. Two PDs from which it is a thing at the time of being outputted, and it is behind in this example, and a degree differs The pulse is shown.

[0031] PD shown in (C) A pulse is changed into the loose wave (integration wave) of the standup shown in (d) with the time constant of time constant circuit 10b. This wave is the threshold V_t of transistor 15b. PD which is not attained By the pulse, transistor 15b does not turn on and, therefore, the data input signal (D input signal) from inverter 16b to D-FF13b is not generated. On the other hand, an integration wave is Threshold V_t . PD to attain By the pulse, transistor 15b is generated, as it turns on and a data input signal shows (e) from inverter 16b, and for this data input signal, an integration wave is Threshold V_t . It is generated until it becomes smallness.

[0032] the clocked into of D-FF13b -- PD a pulse -- time t_D only -- **** delay PD shown in delayed (f) The pulse is supplied. Here, it is a time delay t_D . Same [in the time t_M (refer to drawing (e)) to become settled with the time constant of time constant circuit 10b / almost] or it is t_M . t_D If it selects to smallness a little, it synchronizes with the standup timing of a clock signal (delay pulse PD), and a data input signal is incorporated and latched to D-FF13b.

[0033] Delay PD It is the filter circuit output RD which a latch state is reset and is shown in (g) as a result since D-FF13b will be reset by the output of OR-gate 14b, if a pulse falls. It will be obtained.

[0034] Therefore, lead signal PD according to phase contrast Therefore, it is the threshold V_t of filter circuit 12b, without being inputted into the latter charge pump 5 by letting filter circuit 4b (drawing 1) pass depending on the degree of the phase contrast. Time t_M to become settled It becomes a dead zone.

[0035] phase-lead-lag-network signal PD exceeding a dead zone ***** -- without the wave of the pulse changing, since there is no bird clapper dully like the former comparatively, the thing of the integration [by which it is outputted to the charge pump 5] voltage value change which controls [near the dead zone / come out and] VCO7 shown in drawing 4 as a phase-comparison property is obtained

[0036] In addition, outputs RU and RD of filter circuits 4a and 4b PU and PD Receiving time delay TD If it attaches, it is a dead zone tM. It can compare and ignore at the convergence time (order for 1 or less ms) demanded also as 100ns (10MHZ) or more than it at the time of the channel change of local oscillation frequency.

[0037] Stopping at the circuit of drawing 2 only being shown in an example, it is clear for various circuit deformation to be possible.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of the PLL circuit by this invention.

[Drawing 2] It is the circuit diagram showing an example of the filter circuits 4a and 4b of drawing 1 .

[Drawing 3] It is each part operation wave form chart of the circuit of drawing 2 .

[Drawing 4] It is the phase-comparison property view of the PLL circuit by this invention.

[Drawing 5] It is the circuit diagram of the phase comparator of the conventional PLL circuit.

[Drawing 6] It is each wave form chart of the circuit of drawing 5 of operation.

[Drawing 7] It is each wave form chart of the circuit of drawing 5 of operation.

[Drawing 8] It is the phase-comparison property view of the circuit of drawing 5 .

[Description of Notations]

1 Reference Frequency VCO

2 Counting-down Circuit

3 Phase Comparator

4a, 4b Filter circuit

5 Charge Pump

6 Loop Filter

7 VCO

10a, 10b Time constant circuit

11a, 11b Delay circuit

12a, 12b Latch circuit

13a, 13b D-FF

14a, 14b OR gate

15a, 15b Transistor

16b Inverter

[Translation done.]

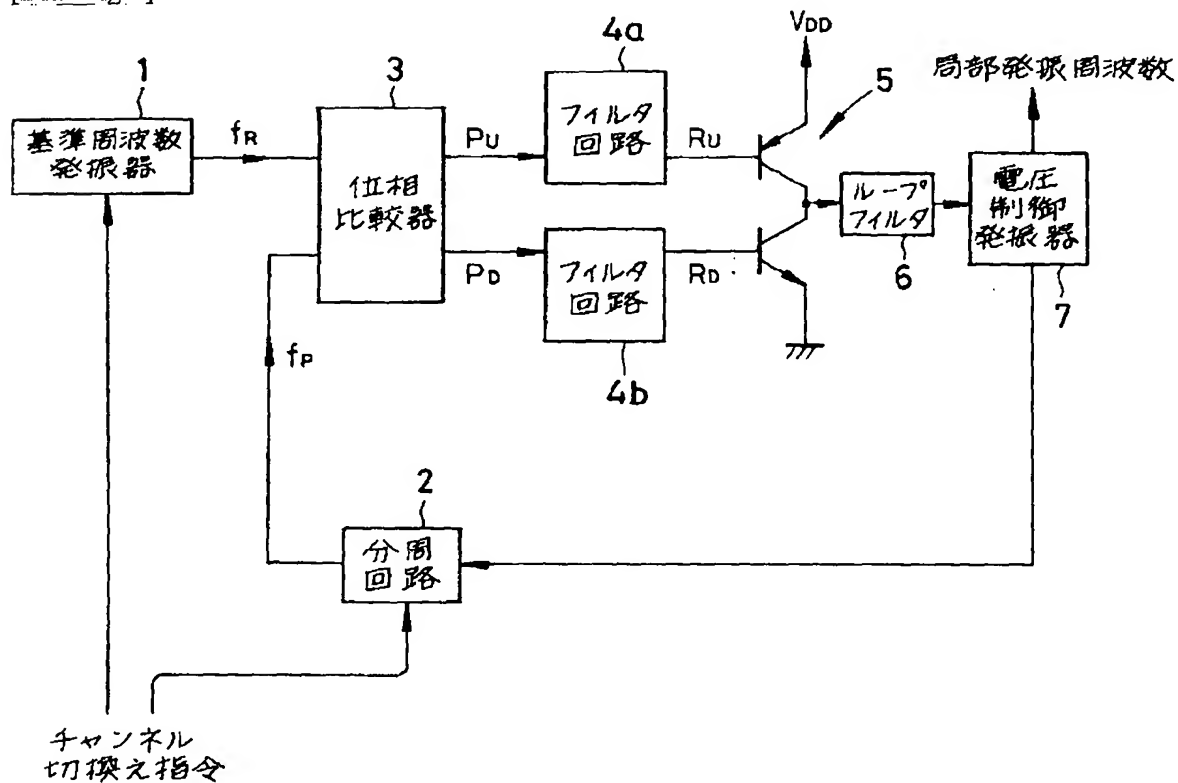
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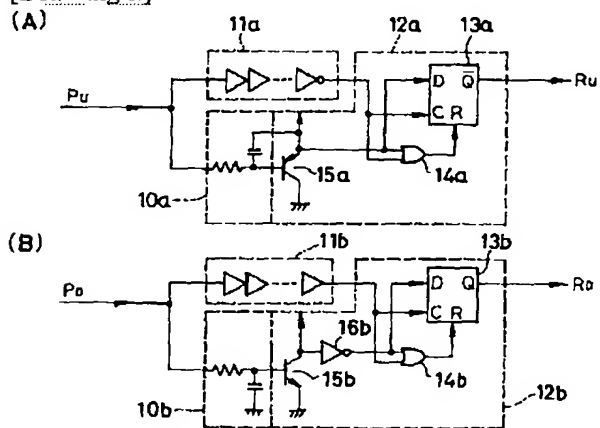
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DRAWINGS

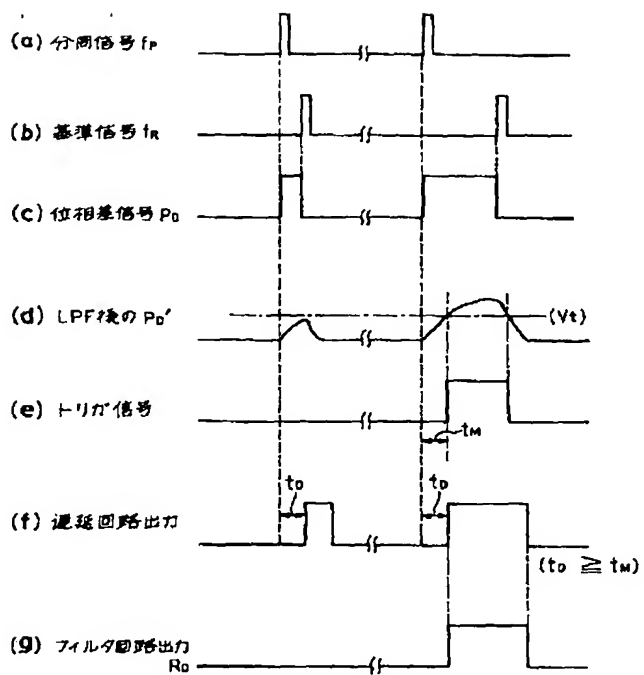
[Drawing 1]



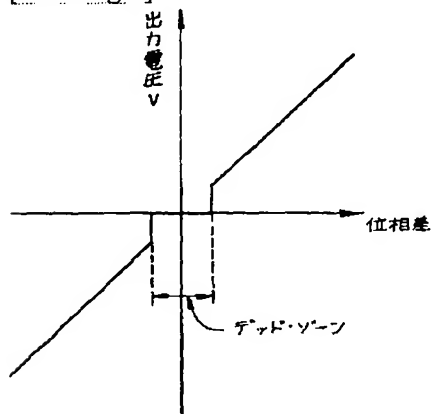
[Drawing 2]



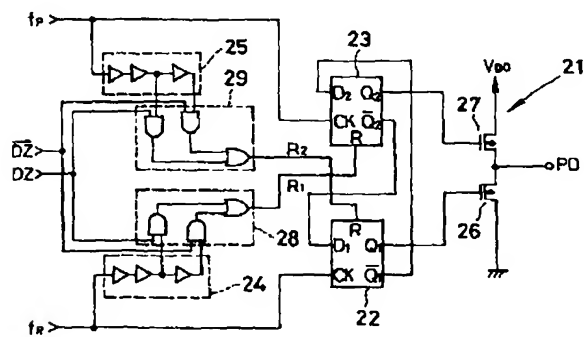
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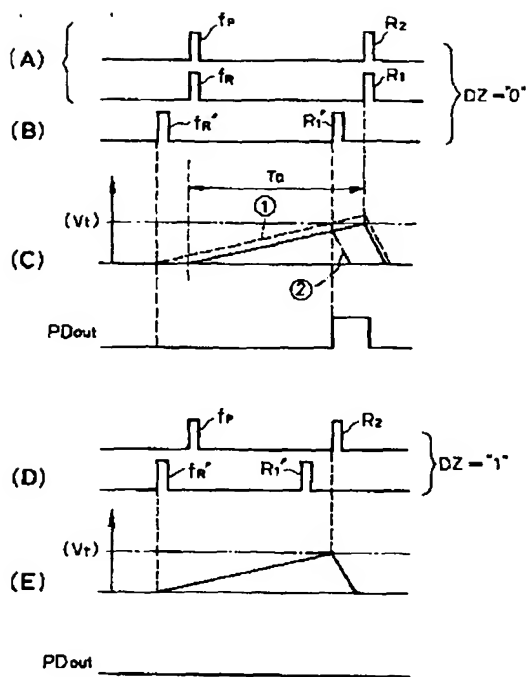
[Drawing 4]



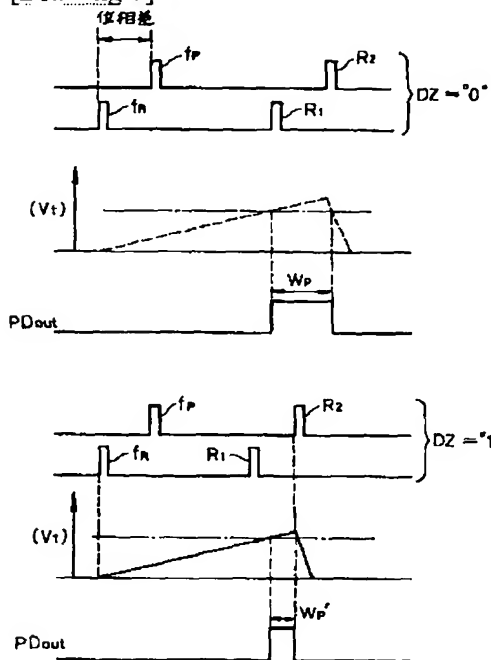
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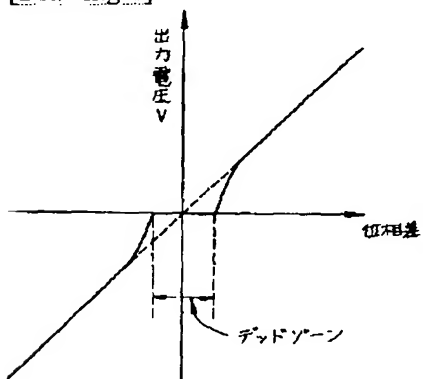
[Drawing 6]



[Drawing 7]



[Drawing 8]



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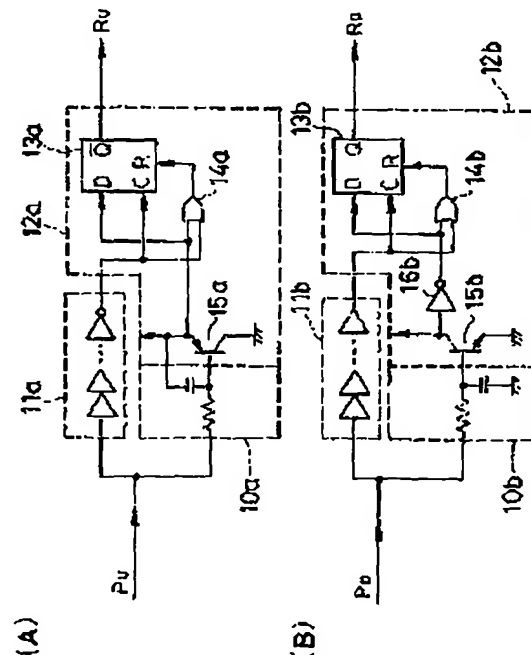
(54) 【発明の名称】 PLL回路

(57) 【要約】

【目的】 受信システムの周波数シンセサイザにおけるPLL回路のS/N改善のために位相比較にデッドゾーンを設けつつ安定な同期収束を可能とする。

【構成】 位相進みPDパルスを遅延器11bで遅延してD-FF13bのクロック入力とする。また、PDパルスを時定数回路10bで積分し、この積分波形をトランジスタ15bの閾値と比較してこの閾値以上のときにパルスを生成する。このパルスをD-FF13bのデータ入力としてPDパルスをラッチし、オアゲート14bでPDパルス消滅時にD-FF13bをリセットする。このQ出力Rbをチャージポンプ、ループフィルタへ供給してVCOの制御電圧を得る。

【効果】 デッドゾーンは時定数回路のCRとトランジスタの閾値で定まり、デッドゾーンより大なるPDパルスはそのまき出力されるので、同期収束が安定となる。



【特許請求の範囲】

【請求項1】 電圧制御発振手段と、この発振出力周波数信号と外部発振周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御発振手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を遅延する遅延手段と、前記位相比較出力を入力とする時定数回路と、前記遅延手段の出力によって前記時定数回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを含み、このラッチ出力を用いて前記制御電圧を生成するよう構成されていることを特徴とするPLL回路。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はPLL（フェイズロックループ）回路に関し、特に変復調技術における安定な同期信号を得るために用いられるPLL回路に関する。

【0002】

【従来の技術】PLL回路は、外部から与えられる基準周波数信号と、VCO（電圧制御発振器）の発振出力を分周した分周出力との位相差を検出し、その位相差に応じた直流電圧によりVCOを制御して安定な発振出力を得るものである。

【0003】受信システムにおいて、この発振出力をローカル発振信号として受信RF信号と混合し、IF信号を作成するようになっており、チャンネル切換え時の周波数切換えには、分周器（プログラムデバイダ）の分周比を変更するか、あるいは基準周波数信号自体を信号源にダイレクトデジタルシンセサイザ等を用いて変化させることにより同調を得ている。

【0004】局部発振周波数シンセサイザにおいては、高速の周波数切換えのためには、系の高利得設計が行われるが、その反面雑音帯域幅が大きくなり、系内に雑音を取り込み易く、発振出力のC/N値が問題となる。こうした場合にネガティブな措置として、位相比較における不感帯（デッドゾーン）を拡げる方法がとられる。

【0005】図5は特開昭63-260317号公報に示された従来のPLL回路の位相比較器の部分を示す回路図であり、21はチャージポンプ、22は第1のD-FF、23は第2のD-FF、24は第1のD-FF 22のクロック入力端子に印加された基準周波数信号fRを遅延する第1の遅延回路、25は第2のD-FF 23のクロック入力端子に印加された分周信号fPを遅延する第2の遅延回路である。28、29はデッドゾーン拡大信号DZに応じて遅延量を選択する回路である。

【0006】次に動作について説明する。D-FF 22の入力端子D1には、D-FFの反転出力Q2が印加され、D-FF 23の入力端子D2にはD-FF 22の反転出力Q1が印加され、出力Q1はチャージポンプ回路

21のNMOS 26のゲートに印加され、出力Q2はNMOS 27のゲートに印加される。

【0007】デッドゾーン拡大信号DZをオフ

（“0”）にすると、遅延回路の最終段の遅延信号が選択回路28、29より選択される。

【0008】まず、分周信号fPに対して基準周波数信号fRの位相が一致しているとき、図6（A）に示す様にfPとfRの立上りにより、D-FF 22、23は共に互いの反転出力“1”を取込んで各々出力Q1及びQ2に出力する。この出力Q1及びQ2は、図6（C）の様に実線で示される傾斜で上昇し、スレッショルド電圧Vtに達する時点Tdで選択回路28、29の出力R1とR2が立上る。

【0009】すなわち、遅延回路24、25の最大遅延量はTdと等しくなる様に設計しており、出力R1、R2によりD-FF 22、23は共にリセットされ、出力Q1及びQ2は低下し、従ってこの場合、NMOS 26、27は共にオンせず、位相差に応じた出力PDは出力されない。

【0010】図6（B）で示される如く、fR'が10nsec早くなった状態では、D-FF 22は“1”を取込み、出力Q1は（C）の点線の如くに立上る。D-FF 23は10nsec遅れてfPの立上りで“1”を取込み、その出力Q2が上昇する。次に選択回路28からR1'が出力されると、D-FF 23はリセットされ、出力Q2はVtに達する前に、（C）の破線の如くに立下がる。

【0011】一方、D-FF 22の出力Q1はVtに達し、選択回路29の出力R2によりD-FF 22がリセットされることになる。従って、出力Q1がVt以上になった期間、NMOS 26がオンとなって、位相差に応じた出力PD“0”が出力される。すなわち、図6（C）の場合には、fRが早くなると、出力R2が出力される前に必ずVtに達することになり、デッドゾーンは零となるのである。

【0012】次に図6（D）はDZ＝“1”の場合であり、DZ＝“0”の時より、遅延量の多い遅延信号が選択される。まずfRとfPの位相が一致している時には、遅延回路の出力R1とR2が発生するのがTdより早くなるので、Q1とQ2はVtに達せずにD-FF 22、23がリセットされる。

【0013】いま、出力R1とR2がTdより10nsec早い遅延信号であるとした時、fRが図6（D）の如く、10nsec早くなった場合、D-FF 22の出力Q1は（D）の実線で示される如く上昇し、Vtに達する直前において、出力R2が発生するためにD-FF 22がリセットされ、Q1は低下する。

【0014】したがって、図6（E）の場合には、fRとfPの位相差が10nsec以内では、出力Q1がVtに達する前に必ずD-FF 22がリセットされること

になり、NMOS26がオンとなって位相差に対応する出力PDが発生されることはない。すなわち、10nsecのデッドゾーンが設けられる。同様にfPがfRより早くなった場合は、10nsec以下であれば、D-FF23の出力Q2がV_{cc}に達する前にD-FF23がリセットされるので、10nsecのデッドゾーンが発生する。

【0015】デッドゾーンを設けることにより、PLL回路がロックしている状態でVCOの外乱となるような制御パルスの頻発が防止され、またジッタノイズ等の雑音信号もカットされ、S/Nを大幅に改善している。

【0016】

【発明が解決しようとする課題】上述した従来の位相比較回路で構成したPLL回路においては、デッドゾーン近傍での位相差に対して、系の反応が鈍化する問題がある。

【0017】例えば、fRがfPに対して12nsec早くなった場合を想定すると、図7に示す様になる。DZ="0"のデッドゾーン0の状態では、出力Q1がV_{cc}を越えている時間は約12nsecとみることができ、PD信号として"1"が12nsec出力されるが、DZ="1"のデッドゾーン10nsecの状態では、出力Q1がV_{cc}を越える時間約2nsecとなり、PD信号として"1"は2nsec間しか続かず、ループフィルタを通してのVCOの制御を行う積分電圧値の変化の割合が鈍くなる。

【0018】この位相比較の特性を図に示すと図8のようになる。fRとfPの位相差が大きい時には、相対的にみてそのデッドゾーン設定分の10nsecで削られる時間が小さくなるため、影響は少なくなるが、デッドゾーン近傍でかなり系としての感度は劣化する。

【0019】具体的には、PLL回路の発振周波数の切替時、シフト周波数付近への変化に支障はないが、収束値付近での同調に影響が出て、収束値に対して振動が尾を引く現象が生じ易い問題点がある。

【0020】本発明の目的は、位相比較時にデッドゾーンを設けつつ安定な同期収束を可能としたPLL回路を提供することである。

【0021】

【課題を解決しようとする手段】本発明によれば、電圧制御発振手段と、この発振出力周波数信号と外部発振周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御発振手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を遅延する遅延手段と、前記位相比較出力を入力とする時定数回路と、前記遅延手段の出力によって前記時定数回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを含み、このラッ

チ出力を用いて前記制御電圧を生成するよう構成されていることを特徴とするPLL回路が得られる。

【0022】

【実施例】以下に本発明の実施例について図面を参照しつつ詳細に説明する。

【0023】図1は本発明の実施例のブロック図であり、基準周波数fRを発生する発振器1の出力は位相比較器3の一入力となる。この位相比較器3の他入力には、VCO7の発振周波数を分周器2にて分周した周波数fPの信号が印加されている。

【0024】位相比較器3からは、位相差に応じたパルス幅の進み信号PDと遅れ信号PUとが出力され、フィルタ回路4a、4bへ夫々入力される。このフィルタ回路4a、4bが本発明の特徴部分の回路であって図2にその一具体例が示されている。このフィルタ回路4a、4bにおいて、デッドゾーンが設定されつつPD、PUのパルス幅（位相差情報を含んでいる）が変化することのない、位相差信号RU、RDが生成される。

【0025】この位相差信号RU、RDはチャージポンプ5を介してループフィルタ6へ入力され積分されることによりVCO7の制御電圧となる。

【0026】このVCO7の出力が受信システムにおけるローカル発振周波数となっており、受信チャンネルの切換え指令に応じて基準周波数発振器1の発振周波数fR及びプログラムデバイダ2の分周比がコントロールされ、PLL周波数シンセサイザを構成している。

【0027】図2(A)、(B)は図1のフィルタ回路4a、4bの各具体例回路図である。まず、図2(A)を参照すると、進み信号PUは遅延回路11a及び時定数回路10aへ夫々入力される。遅延回路11aの遅延出力は、ラッチ回路12aを構成するD-FF13aのクロック入力となる。

【0028】時定数回路10aの出力は、ラッチ回路12aを構成するPNPトランジスタ15aのベース入力となり、このトランジスタ15aのエミッタ出力はD-FF13aのデータ入力となると共に、オアゲート14aの一入力となる。このオアゲート14aの他入力には遅延回路11aの遅延出力が印加され、オア出力はD-FF13aのリセット入力となっている。そして、D-FF13aの反転Q出力がRUとなる。

【0029】図2(B)は遅れ信号PD側についても、具体的に遅延回路11b、時定数回路10b及びラッチ回路12bからなっているが、時定数回路10bの電源ラインの極性、ラッチ回路内のトランジスタ15bの極性が進み信号PU側とは逆となっており、また、トランジスタ15bのコレクタ出力はインバータ16bにて極性反転されてD-FF13bのデータ入力及びオアゲート14bの一入力となっている。

【0030】図3は図2(B)の回路の動作を示す各信号波形図であり、fRがfPに対して位相が遅れたと

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き、遅れ信号PDが出力された場合のものであって、本例では遅れ度合が異なる2つのPDパルスを示している。

【0031】(C)に示すPDパルスは時定数回路10bの時定数によって(d)に示す立上りの緩やかな波形(積分波形)に変換される。この波形がトランジスタ15bの閾値Vtに達しないPDパルスでは、トランジスタ15bはオンせず、よってインバータ16bからD-FF13bへのデータ入力信号(D入力信号)は生成されない。一方、積分波形が閾値Vtに達するPDパルスでは、トランジスタ15bはオンしてインバータ16bからデータ入力信号が(e)に示す如く生成され、このデータ入力信号は積分波形が閾値Vtより小となるまで生成される。

【0032】D-FF13bのクロック入力にはPDパルスが時間tDだけ遅延された(f)に示す如き遅延PDパルスが供給されている。ここで、遅延時間tDと時定数回路10bの時定数により定まる時間tM(図(e)参照)とを殆ど同一か若しくはtMをtDより若干小に選定しておけば、クロック信号(遅延パルスPD)の立上りタイミングに同期しD-FF13bにはデータ入力信号が取込まれてラッチされる。

【0033】遅延PDパルスが立下がると、オアゲート14bの出力によりD-FF13bはリセットされるので、ラッチ状態がリセットされ、結果として(g)に示すフィルタ回路出力RDが得られることになる。

【0034】従って、位相差に応じた進み信号PDは、その位相差の度合によってはフィルタ回路4b(図1)を過すことにより後段のチャージポンプ5へ入力されることなく、よってフィルタ回路12bの閾値Vtにより定まる時間tMがデッドゾーンとなるのである。

【0035】デッドゾーンを越える位相進み信号PDについては、そのパルスの波形が変化することなくチャージポンプ5へ出力されるので、デッドゾーン近傍において、VCO7の制御を行う積分電圧値の変化の割合が、従来の如く鈍くなることのないので、位相比較特性としては図4に示すものが得られる。

【0036】尚、フィルタ回路4a、4bの出力RU、RDのPU、PDに対する遅延時間TDについては、デッドゾーンtMを100ns(10MHz)またはそれ以上としても、ローカル発振周波数のチャンネル切換え

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時に要求される収束時間(1ms以下のオーダー)に比し無視できる。

【0037】図2の回路は単に一例に示すに止まるもので、種々の回路変形が可能であることは明らかである。

【0038】

【発明の効果】以上のべた様に、本発明によれば、PLL受信システムにおいて要求される高速チャンネル切換えのために高利得でPLLを設計した場合にも、位相比較におけるデッドゾーンを設定しつつチャンネル切換え時に収束値近傍での振動や尾引き現象を伴うことのない高性能PLL回路が実現できるという効果がある。

【0039】定量的に述べると、S/N値で10dB以上の改善があり、チャンネル切換え収束時間で2ms以上の短縮が図れるものである。

【図面の簡単な説明】

【図1】本発明によるPLL回路のブロック図である。

【図2】図1のフィルタ回路4a、4bの一例を示す回路図である。

【図3】図2の回路の各部動作波形図である。

【図4】本発明によるPLL回路の位相比較特性図である。

【図5】従来のPLL回路の位相比較器の回路図である。

【図6】図5の回路の各動作波形図である。

【図7】図5の回路の各動作波形図である。

【図8】図5の回路の位相比較特性図である。

【符号の説明】

1 基準周波数発振器

2 分周器

3 位相比較器

4a、4b フィルタ回路

5 チャージポンプ

6 ループフィルタ

7 VCO

10a、10b 時定数回路

11a、11b 遅延回路

12a、12b ラッチ回路

13a、13b D-FF

14a、14b オアゲート

15a、15b トランジスタ

16b インバータ

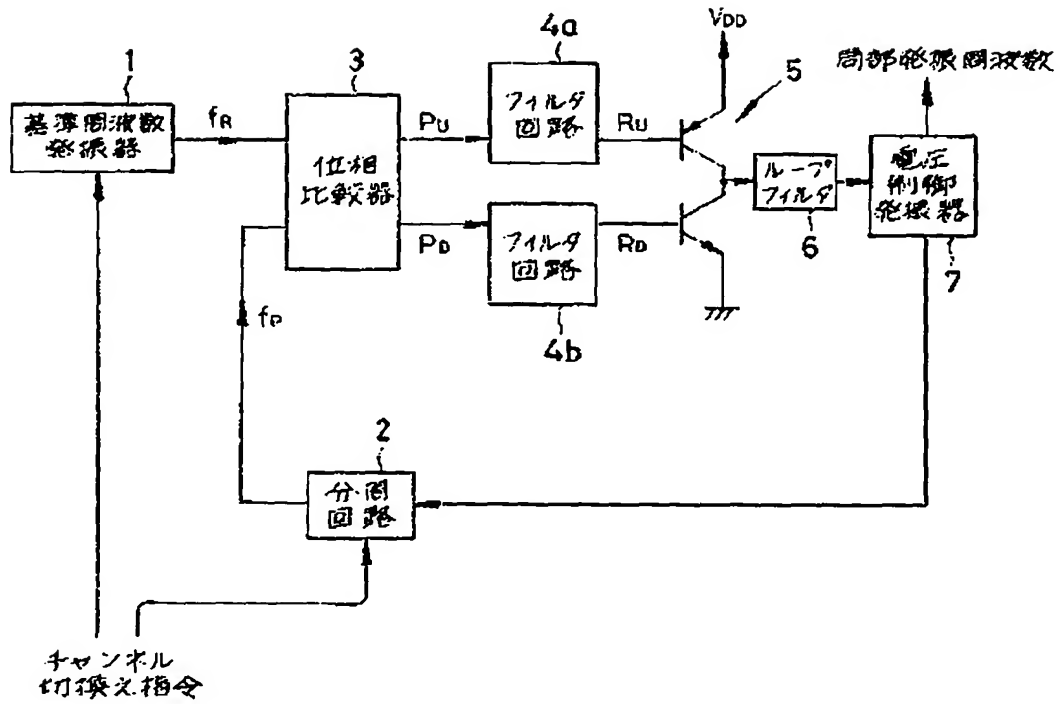
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20

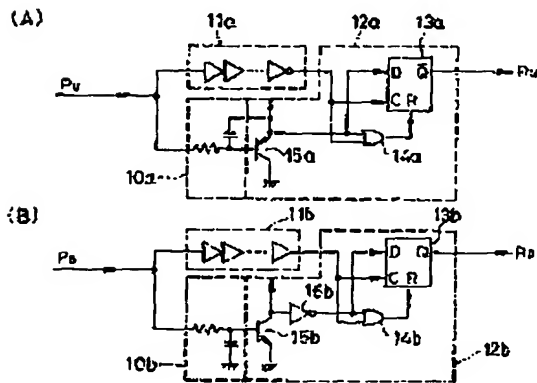
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40

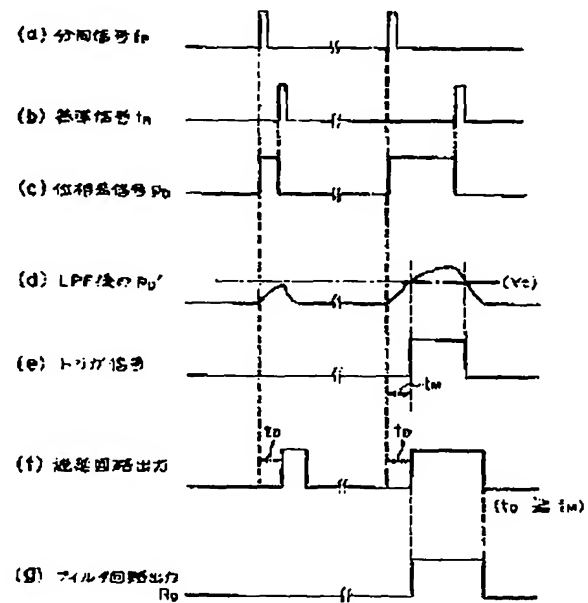
【図1】



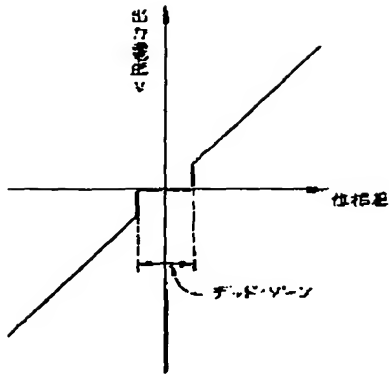
【図2】



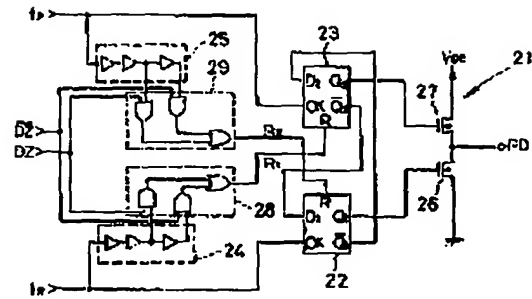
【図3】



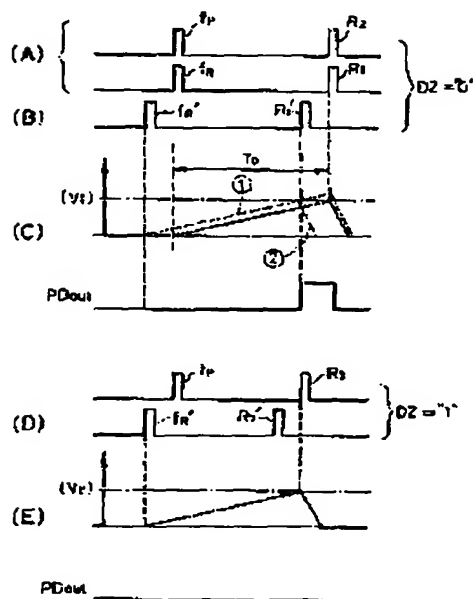
【図4】



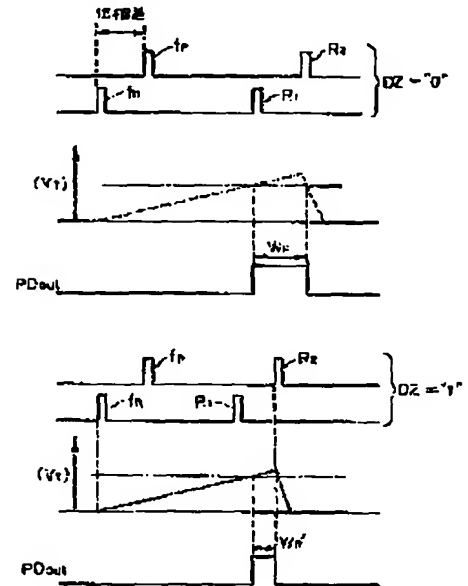
【図5】



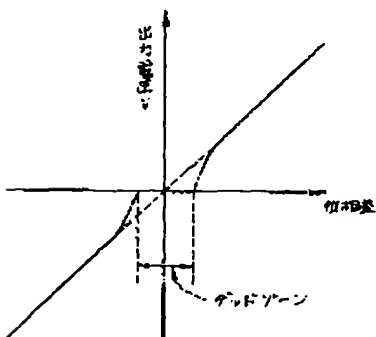
【図6】



【図7】



【図8】



【手続補正書】

【提出日】平成6年1月10日

【手続補正1】

【補正対象書類名】明細書

【補正対象項目名】発明の名称

【補正方法】変更

【補正内容】

【発明の名称】 PLL回路

【手続補正2】

【補正対象書類名】明細書

【補正対象項目名】特許請求の範囲

【補正方法】追加

【補正内容】

【特許請求の範囲】

【請求項1】 電圧制御発振手段と、この発振出力周波数信号と外部発振周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御発振手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を遅延する遅延手段と、前記位相比較出力を入力とする時定数回路と、前記遅延手段の出力によって前記時定数回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを含み、このラッチ出力を用いて前記制御電圧を生成するよう構成されていることを特徴とするPLL回路。

【請求項2】 前記位相比較手段は、前記発振出力周波数信号と外部発振周波数信号との一方に対する他方の位相ずれを検出して位相差み及び移相遅れに夫々対応した位相比較出力を生成するよう構成されており、前記遅延手段、前記時定数回路及びラッチ手段の各々は前記位相差み及び位相遅れに対応した位相比較出力に夫々対応して設けられていることを特徴とする請求項1記載のPLL回路。

【請求項3】 前記遅延手段の遅延時間は、前記位相比較における不感帯（デッドゾーン）に相当する時間に設定されていることを特徴とする請求項1または2記載のPLL回路。

【手続補正3】

【補正対象書類名】明細書

【補正対象項目名】0006

【補正方法】変更

【補正内容】

【0006】次に動作について説明する。D-FF22の入力端子D1には、D-FF23反転出力Q2が印加され、D-FF23の入力端子D2にはD-FF22の反転出力Q1が印加され、出力Q1はチャージポンプ回路21のNMOS26のゲートに印加され、出力Q2はNMOS27のゲートに印加される。

【手続補正4】

【補正対象書類名】明細書

【補正対象項目名】0015

【補正方法】変更

【補正内容】

【0015】デッドゾーンを設けることにより、PLL回路がロックしている状態でVCOの外乱となるような制御パルスの頻繁な発生が防止され、またジッタノイズ等の雑音信号もカットされ、S/Nを大幅に改善している。

【手続補正5】

【補正対象書類名】明細書

【補正対象項目名】0017

【補正方法】変更

【補正内容】

【0017】例えば、 f_R が f_P に対して12nsec早くなった場合を想定すると、図7に示す様になる。DZ="0"のデッドゾーン0の状態では、出力Q1が V_T を越えている時間は約12nsecとみることができ、PD信号として"1"が12nsec出力されるが、DZ="1"のデッドゾーン10nsecの状態では、出力Q1が V_T を越える時間は約2nsecとなり、PD信号として"1"は2nsec間しか続かず、ループフィルタを通してのVCOの制御を行う積分電圧値の変化の割合が鈍くなる。